

5        METHOD AND SYSTEM FOR ASSISTING THE PASSAGE OF AN ENTITY  
         THROUGH SUCCESSIVE ZONES TO A DESTINATION

Field of the Invention

         The present invention relates to a method and system for  
         assisting the passage of an entity through successive zones  
10        to a destination. It is particularly, but not exclusively,  
         related to a method and apparatus for assisting the  
         movement of passengers and/or luggage, and especially for  
         reducing passenger related delays in a transport  
         environment.

15        Background

         Recent developments in smart passive and/or active labels  
         (e.g. devices known as Radio Frequency Identification tags  
         or RFIDs) mean that the cost of such labels has  
         dramatically reduced whilst their availability and  
20        reliability have increased significantly. This makes their  
         use possible in arenas such as logistics of goods and  
         parts. For example, companies such as Philips and Motorola  
         manufacture the active or passive RFIDs that are integrated  
         in stickers or labels by companies such as 3M. Such  
25        devices enable real time tracking of entities (e.g.  
         passengers, luggage, etc.) by sensors located in a variety  
         of locations.

Thus US patent 4711994 proposes a method for maintenance of a close and accurate security surveillance for both passengers and their baggage on a public conveyance to ensure that, before departure, baggage is not loaded aboard the conveyance without prior positive identification that the owner or the passenger has, in fact, been properly boarded.

US patent 6158658 elaborates this concept to once again enhance passenger security by matching the register of passengers who actually boarded with that of loaded luggage.

Other patent publications revolve around the concept of matching passengers with luggage for improved security. Thus US patent 6222452 proposes using RFIDs to tag luggage and focuses essentially on matching passengers with luggage; US patent application 20030128100A1 focuses on the continuous tracking of tags throughout a facility; and EP-A-0940763 focuses on the reconciliation of passengers, luggage and cargo.

The above prior art systems generally address the problems of tracking passengers and/or luggage, and of matching passengers and luggage at their destination (e.g. an aircraft). However, none of the systems provide a method which can track the progress of passengers, vehicle crews, on-board staff and/or luggage towards their final destination and can anticipate and take appropriate action, such as preventative action, before a process failure occurs.

Furthermore, whilst the above prior art suggests potential benefits for the system operators, such as airlines and airports, there is little or no benefit for passengers.

5 The above prior art also does not relate to management of vehicle crews, although delayed crew arrivals can be an issue for operators and passengers alike. For example, problems can arise if technical issues on incoming vehicles (aircraft/trains/buses) result in late arrival of crew who are due to move on to work on a different vehicle or, for  
10 example in cases of industrial action, if the operator only has a limited number of crews that it can rotate between vehicles. Knowing where available crews are and how far/long they are away from the vehicles that they are due to work on would be very useful for the aforementioned  
15 operators.

The above prior art systems also do not demonstrate the ability to react to operational variations.

Furthermore, the above prior art systems also are not adapted for minimising the generated data arising from the  
20 tracking of a large number of entities.

#### Summary of the Invention

An aim of the present invention is to provide a method and system which address one or more of these issues.

25 Accordingly, the present invention introduces the concept of a sequence of zones through which an entity (e.g. a passenger, a member of a vehicle crew or staff, or an item of luggage) travels on its way to a destination (e.g. the departure gate of an airport). This allows the adoption of a time-based and zone-based system, where a predetermined

arrival time at the destination can be used as the driver for ensuring the entity progresses to the destination on time.

Thus a first aspect of the present invention provides a  
5 method of assisting the passage of an entity through successive zones to a destination, including the steps of:  
    associating an identifier with said entity;  
    creating a plurality of required incidents for said  
entity, each required incident having a place reference and  
10 a time reference associated with it, the required incidents including a final incident for which the place reference is the destination and the time reference is a predetermined time;  
    at intervals, detecting the presence of said entity in  
15 one of said zones and the time of said presence, thereby generating a match;  
    registering correspondences between the matches thus-generated and said required incidents; and  
    generating an alert for the entity when the time  
20 reference for a required incident is reached and that incident does not have a corresponding match.

The entity may be a person or an item of luggage. The alert may be for example a speaker announcement, an e-mail (e.g. delivered to a Blackberry(TM) device), a voice  
25 message, a pager message, an MMS message, a message delivered by a person or an SMS message to the person. Where the entity is a person, the message may be directed to the person. Where the entity is an item of luggage, the message may be directed to a baggage handler.

30 Where the alert is delivered to a person, then any available system or protocol can be used, including, but

not limited to, WIFI, WIMAX, BlueTooth, infra red or local relaying. For short range protocols or systems, the alert can be delivered directly to a device (e.g. a phone, PDA or headset) carried by the person.

5 It is envisaged that the invention may be applied to many situations, for example to travel interchanges, termini or transportation hubs such as airports, shipping ports, bus and train stations. Likewise, the method may be used in civil or military applications. The method is also  
10 applicable to events, e.g. sports events.

In preferred embodiments, the destination is a departure gate of the transportation hub or travel interchange, and in particular of an airport. The zones in such cases are areas within the hub and optionally areas of the  
15 surrounding environment as well.

In some embodiments the method may be implemented in an "arrivals" area of the transportation hub or travel interchange. In such embodiments, the destination may be, for example, the baggage collection area, passport control  
20 or customs.

Choke points in the movement of entities, for example security or passport control areas, may be separately designated zones. Choke points outside the facility (e.g. traffic junctions, toll gates, service stations) may also  
25 be separately designated zones.

Choke points are taken to be places through which all, or substantially all entities, or entities of a particular type pass on the way to a destination. This includes so called "convergence points" which are places that there is

a high degree of probability that an entity will pass through.

The zones are not necessarily contiguous or overlapping, and may be separated by areas which are not part of any zone.

Typically, the identifier is a wireless identification tag, such as an RFID. In certain embodiments the tag may be a passive tag which is energised by a transmitted signal (e.g. an RF signal), which may be transmitted from a detector.

In other embodiments, the identifier is a barcode, which may be printed on a badge, label or other form of documentation and read by a scanner or inputted by an operator.

The method may also include the step of changing a required incident in response to a change in operational conditions. For example, in an airport passenger based embodiment, delays at passport control may increase the time required for passengers who have not passed through passport control to reach their departure gate. The time references of required incidents relating to zones which are the other side of passport control from the departure area (destination) may therefore be changed to earlier times. Alerts may therefore be generated earlier which advise passengers to move towards passport control. As a result, delays in passengers arriving at departure gates as a result of the delays at passport control can be reduced or eliminated.

Alternatively, for example if the departure of a vehicle is delayed, some or all of the required incidents relating to

entities associated with a particular final incident may be changed in response to an event. As a result, affected entities, in particular people, may be allowed to return to previous zones or to stay longer in the zones they are currently in, or even prevented or encouraged not to proceed to an adjacent zone. Thus, for example, passengers in a transport environment may thus enjoy the use of airport facilities such as shops, businesses and rest areas rather than having to proceed to the next area only to be delayed upon arrival in that zone.

Furthermore, a passenger who may have wished to move to the next zone too early may be spared the need to wait in a queue if one is forming in that zone (e.g. at a choke point) or if the next zone is starting to become overcrowded. The method may generate an alert for such passengers, which may result in them being told, e.g. by staff or by other mechanism, that they ought to stay in the zone where they currently are.

It is not necessary to continually monitor the location of every entity of interest to the system. The method may be adapted to interrogate zones for particular identifiers only at defined times. This can help to reduce the volume of data collected from the zones. For example, the sensors at or around a destination may only be activated at a given time before the predetermined time of the final incident. In addition, the number of sensors used to cover an entire complex need not be as high as for a system which provides continual tracking, since the sensors may only be installed at particular areas (corresponding to zones) rather than at all points along all possible routes.

Further advantages of the present invention may arise when one or more entities are linked or associated with each other, for example when entities are both passengers and items of luggage, and where each luggage entity is  
5 associated with one or more passenger entities (and/or vice versa). Some of these advantages may result in increased advantage to the passenger, thereby making acceptance by passenger users more likely.

Alternatively or in addition to the above situation where a  
10 passenger is associated with his or her luggage or a soldier is associated with his or her kit, a family arriving at an automated check-in point or usual manned check-in area or other areas may thus create an "inventory" of associated passengers (including or excluding luggage)  
15 which may all be checked-in or moved as one entity. This may result in a reduction in transactional time spent in checking in that overall group defined by this "inventory".

Furthermore, the order in which luggage is loaded onto a vehicle (e.g. aircraft, bus, train, etc.) at the  
20 destination may be arranged by streaming the order in which the luggage is delivered to the vehicle. In this way, it could be arranged that the luggage of passengers travelling in superior classes be delivered first onto a conveyer belt in the arrival or luggage collection area when the vehicle  
25 reaches its destination. Alternatively or additionally, the luggage associated with passengers arriving late at the check-in, or deemed to be at risk of arriving late from a zone location in or outside of the facility or airport, may be located so that it is positioned in a convenient  
30 location for offloading, thus reducing or eliminating the delay caused by the need to remove such luggage.



The invention can make it possible to confirm to a passenger prior to departure that their luggage is also on the vehicle in which they are travelling. Alternatively, in situations where delays have caused luggage to fail to reach the vehicle before the departure time, action can be taken to minimise the inconvenience to the passenger, and redress, such as compensation or alternative arrangements, can be offered to the passenger before arrival at the destination of the vehicle. Such a service would reduce the inconvenience of passengers in waiting at the vehicle destination to determine whether their luggage has arrived, or allow them to make alternative arrangements in advance of their arrival at the vehicle destination.

In an airport environment, for example, the invention can make it possible for passengers and operators to have a better appreciation of potential overbooking of a vehicle, such as an aircraft. If overbooking has, or is likely to occur, the operator can manage the passenger's expectations, and avoid luggage issues well before the passenger has arrived in the embarkation area. This may increase the ability of the airline operator to re-direct the passenger to a different aircraft with their associated luggage in good time, and thereby reduce the cost to the operator of having to compensate passengers. It may also improve the travel experience of passengers by reducing the chance that the vehicle is overbooked by giving an earlier understanding of where passengers are on their way to the departure area.

The method of the present invention may offer further benefits to a passenger entity. For example, where the method is implemented in a transport terminal, a passenger may be able to feel less pressured and/or more relaxed

whilst shopping in a terminal building, or whilst waiting in a lounge, and spend less time checking departure boards etc., since they would know that personalised messages will ensure that they move to the next zone in good time to ensure their arrival at the destination by the predetermined time. This may also provide advantages to the operator of the terminal area, as passengers may spend more time in a shopping or refreshment area as a result.

In addition, zones may be defined in areas where advertisement space is located and that the owner usually rents out to advertisers or commercial operators. Both the advertisers/commercial operators and the owner of the space may benefit from knowing the actual time spent by people (i.e. potential customers) in such zones and rental pricing may thus be linked to actual time spent by potential customers in that zone and backed-up with actual evidence of this time.

Thus the present invention may allow the owner to increase their revenues from such advertising space by using the customer dwell times provided in management reports produced by the method or system of the invention.

Alternatively or additionally, zones may be defined in areas where passengers or other people impact on the use of utilities such as water, electricity, waste, etc. and thus the method or system of the invention may yield information which may allow the operator or owner of the facility study or analyse the movement pattern of passengers or users of the facility and trends over the course of a day/week/year of such use, and thus proactively manage the use of such utilities. Thus the present invention may deliver a lower cost or use of such resources to the owner or may have an

impact on charges which may benefit the owner or operator of such facilities.

The invention may also enable the construction of cinemas and other time dependent entertainment in transport  
5 terminals because of the ability to associate passengers with their time to departure.

The step of detecting may also be carried out at one or more of the entrances to or exits from a retail unit or area, a toilet or rest-room or a restricted access area  
10 (such as a business lounge). Data regarding the usage of these facilities may thus be generated, stored and analysed.

Data of this type may allow the operators of the facilities, or of the entire location (e.g. the  
15 transportation hub) to better manage the facilities. In particular the usage patterns of the facilities could be analysed and staffing, cleaning or maintenance levels adjusted accordingly. For example, a retailer could determine footfall patterns throughout a day or week or  
20 year and open/close checkouts accordingly or determine the effectiveness of a particular retail space arrangement including advertisement space.

The method of this aspect of the present invention may also be adapted or operated so as to customise the journey of  
25 individual passengers or groups of passengers. Such customisation may be as a result of operational conditions, such as local flow rates, or as a result of classification of passengers. For example, the method may be adapted so that passengers who have paid for superior class tickets  
30 are provided with faster streaming and prompts which allow

them to shorten their total journey time through the zones. In another example, alerts generated for particular groups of passengers might suggest that they take alternative routings to reach their destination, e.g. as a result of delays at choke points on some routings.

The method may also use data relating to each entity or group of entities, for example a passenger's name, ultimate destination or flight number to tailor alerts for entities which have not reached the destination by the predetermined time. This allows the alerts, whether they are messages sent or displayed, or broadcast announcements, to be personalised.

The method may also use data relating to the entity to adjust the creation of the required incidents. For example, time references of required incidents may be adjusted to take account of passengers who are less mobile, or who require assistance with boarding.

The zones of the present invention need not be restricted to areas directly associated with the destination (e.g. airport facilities and buildings). Further zones may be defined outside this traditional area of influence, and required incidents set up for key events or time references in those zones, with associated alerts being generated where necessary. This can result in additional services being offered to a passenger.

Where the zones cover areas which are not directly associated with the destination, alerts which can be transmitted to the person, e.g. e-mails, voice messages, pager messages and MMS/SMS messages are particularly useful.

For example, if the start location of the passenger's journey to the destination is known to the operator of the invention, a required incident could be generated with a time reference by which the passenger should have started the journey. The alert generated for this incident could be a telephone call to the passenger's home number, or an SMS/MMS message to the passenger. If the start location is a facility which deals with a number of passengers, such as an airport hotel, a match could be generated by the passenger's departure from that location.

This approach could also be used in situations where the exact starting location of the passenger is not known, for example by generating an alert which informs the passenger that they should be within a certain distance of the destination.

Further inputs, for example from GPS systems, current 2G cell based technology, or other zone based portable device location information, traffic monitoring systems and/or train timetables could be used to calculate or adjust the time reference of such alerts.

Combination with other location systems such as the ability of mobile telephone operators to locate a switched-on handset to within a certain area, or long-rang detection devices could add further services to the customer, whilst reducing the likelihood of a passenger failing to reach the destination before the predetermined time due to external problems.

Thus in development of the invention, a number of different technologies may be integrated to provide a method (or system) which covers the whole (or substantially the whole)

journey of the entity from outside a monitored facility (where the destination is) to its destination.

For example, outside of an airport, a passenger entity may be tracked by GSM cell based ("2G") technology. A mobile  
5 phone "track" is generally paid for by service providers (i.e. the operators of the present invention). With 2G technology and no additional software on the passenger's phone or the mobile operator's network, allows the service provider to determine the passenger's location to within a  
10 3km radius outside towns and a 50m (or smaller) "cell" within a town.

As mobile telephone technology advances, the granularity of the technology may allow a more refined positioning of the passenger outside of the airport. For example, with 2.5G  
15 and 3G services, the track can be made to within a few metres. However, since the present invention is principally concerned with the zone in which the passenger is, a high level of accuracy in locating the passenger is not necessarily required, and the amount of data that is  
20 provided to the system of the invention can be managed accordingly.

In a further development, the identifiers may be provided to customers on a permanent basis, e.g. as part of "loyalty cards". If this is the case, then sensor positioned, e.g.  
25 in petrol stations or toll booths outside the facility can create zones which do not rely on mobile devices or tracking of mobile telephones.

There are also a number of proposed cheap long-range detection devices associated with local networks of which  
30 wOzNet™ is one example.

The wOz Platform™ system includes an innovative wireless network, a system reference design, and an online service that serve as the foundation for a range of location, status, control, and communications solutions for consumers and businesses. The heart of the wOz Platform™ is the wOzNet™ network, a unique local wireless network that provides long range and long battery life at a low cost.

The present invention may also be used to enable management of the numbers of entities, and in particular people, in a particular location, for example for safety or environmental reasons. The method of the present aspect may thus comprise the further steps of:

- setting a limit for the number of people permitted in at least one of the zones;
- counting the number of people in said zone;
- comparing said number to said limit; and
- creating a signal when the number exceeds said limit or when the number approaches said limit to enable restriction of the number of people moving into said zone.

Thus the present invention can allow the number of people entering a particular zone to be restricted for a period of time to reduce or prevent over-crowding. The method can be further adapted so that specific people (e.g. passengers who have a significantly later departure time) are restricted from entering an overcrowded or busy zone, thus giving preference to others who need to reach their destination at an earlier time.

Alternatively or additionally, the invention may be adapted to move people from a busy zone to subsequent zones to prevent overcrowding and allow further people to enter a congested zone.

Thus the method of the present aspect may comprise the further steps of:

setting a limit for the number of people permitted in at least one of said zones;

5       counting the number of people in said zone;

comparing the number to said limit; and

generating an alert when the number exceeds said limit or when the number approaches said limit to increase the number of people moving out of said zone.

10       The above additional features may allow the method of the present aspect to effectively adjust the number of people entering and leaving one or more zones. This may allow safety limits on overcrowding to be maintained, and may also prevent unnecessary queuing for services (e.g.

15       security scans/passport control) in a zone. In addition the method may allow the operator to adjust the staffing levels in a particular zone depending on the number of people present.

The limits referred to above may vary over time. In  
20       particular a zone may have a particular selection of limits with an appropriate limit being chosen depending on the time or day (or both). The limits can also be actively adjusted, dependent on the time, the existing operating conditions in the facility or as a result of feedback of  
25       data relating to other zone conditions.

The monitoring or counting of the number of entities may also including monitoring or counting the number leaving or arriving in the zone.

The present invention may also provide benefits to the  
30       operator which is concerned with the entities arriving at



the destination by the predetermined time, by reducing the likelihood of process failure due to a delay at that point in their process. This can lead to a reduction in overall costs due to delays, as well as providing statistical  
5 information regarding the cause or type of entity (especially when the entity is a human) which leads to any such delay.

The invention may also provide a service which differentiates the operator from its competitors, and thus  
10 may provide a competitive advantage.

The method of the present aspect may also provide the step of analysing the matches. Whilst such analysis can be carried out in "real time" or substantially in "real time", the analysis is preferably carried out on historic data  
15 that has been collected over a period of time.

The results of the analysis may be used to adjust either or both the place or time reference of one or more required incidents for current and future incidents.

Thus, as a result of the above statistical profiling/  
20 analysis, trends in activity and capacity over the course of a day, week, month or year can be used to set the required incidents appropriately (e.g. to reduce the likelihood of delays in particularly busy periods). The result of such analysis(es) may be used at an aggregates  
25 data or at any other level or granularity by the operator of the method or system of the invention, for whatever purpose.

Alternatively or additionally to such analysis, the frequency of final incidents (corresponding, for example,  
30 to the frequency of departures from a hub) may be used as

an indicator of the activity in the zones, and so the time reference and/or place reference of one or more required incidents adjusted accordingly.

For example, as the frequency of flights in an airport increases during a day or season, there is normally a corresponding increase in the time that it takes a passenger to reach the departure gate from the check-in area, due to greater demand on services such as security checks or passport controls. In such a situation, the time references of required incidents during this period can be made earlier than they are during less busy periods, and thus delays reduced or avoided.

Alternatively or additionally, the place reference of required incidents can be adjusted based on information regarding the number and type of people in or passing through one or more zones in a particular period, thus routing people who do not have to pass through busy zones via alternative, e.g. less busy, routes to their destination.

In particular information regarding the type of people covered by the invention may be considered and analysed as discussed above. For example, the behaviour patterns of different types of passengers (retired, disabled, business, men, women, families, etc.) may vary according to the time of the day/week/year, as may their share of the total number of people covered by the method/system. The method may categorise each entity into particular types and assign time and place references of required incidents according to that type. The method may also collect data about the movement of each type of entity thus classified, which can be processed in any of the ways described above.

A development of the present aspect provides a method which further includes the step of detecting the passage of a person through a defined area using secondary detection means and matching each such passage with a detected  
5 passage an identifier through the same area, wherein when the passage of a person is detected without a corresponding detected passage of an identifier, an alert is generated.

By using secondary detection means, such as an infra-red detector, a video sensor or a light beam, the above  
10 development allows each person passing through the defined area to be checked to ensure that they are carrying the identifier associated with them. The alert in the above development is preferably directed to staff in the defined area, who can respond to the alert by checking the status  
15 of the person without the identifier, and take appropriate action, such as issuing a further identifier.

Preferably the steps in the above development are performed at a choke-point in the passage of the person to the destination, and thus all or substantially all of the  
20 people concerned are checked in this manner at least once on their way to their destination.

Implementation in an arrivals area can allow the method to be utilised by service providers such as hotels, taxi companies or car rental companies to determine passenger  
25 flow data and also passenger preferences.

A second aspect of the present invention provides a system for assisting the passage of an entity through a plurality of successive zones to a destination, the system including:  
an identifier for said entity;  
30 storage means for storing a plurality of required

incidents for said entity, each required incident having a place reference and a time reference associated with it, the required incidents including a final incident for which the place reference is the destination and the time reference is a predetermined time;

detection means for detecting, at intervals, the presence of said entity in one of said zones and the time of said presence, thereby generating a match;

means for registering correspondences between the matches thus-generated and said required incidents; and

alerting means for generating an alert for the entity when the time reference for a required incident is reached and that incident does not have a corresponding match.

The entity may be a person or an item of luggage. The alert may be for example a speaker announcement, an e-mail, a voice message, a pager message, an MMS message, a message delivered by a person or an SMS message to the person.

Where the entity is a person, the message may be directed to the person. Where the entity is an item of luggage, the message may be directed to a baggage handler.

Typically, the identifier is a wireless identification tag, such as an RFID. The tag may be a passive tag which is energised by a transmitted signal (e.g. from the detection means). The detection means may be RF sensors.

In embodiments of the invention the identifier may be a barcode which may be printed on a badge, label or other form of documentation and read by a scanner or inputted by an operator. The detection means in such embodiments are laser scanners or readers. In other embodiments, combinations of different types of detection means and

identifier may be used, e.g. wireless identification tags and barcodes.

Preferably the identifier is associated with each entity in such a way that there is little or no change to the way in which the entity is handled or needs to behave. For example, in an airport based embodiment, the identifiers may be attached to or printed onto the boarding cards of passengers. Since the passenger needs to retain this boarding card with them in order to board the aircraft anyway, there need not be any additional requirement on the passenger or little to none on the operators of the aircraft or airport.

In a development of the system, the system further includes secondary detection means for detecting the passage of a person through a defined area, means for registering a correspondence between each such passage and a passage of an identifier detected by the detection means, and alerting means for generating an alert when the passage of a person is detected by said secondary detection means without a corresponding passage of an identifier being detected.

The secondary detection means may include one or more infra-red detector(s), video sensor(s), light beam(s), pressure sensor(s), motion detection sensor(s) or mechanical sensor(s) (e.g. gates, turnstiles, switch or counting sensor) or other mechanical devices capable of detecting the passage of the entity through the check point or zone or choke point or any combination of the said secondary detection means at the said location.

Optionally the system may further comprise storage means for storing a limit value for the number of people

permitted in at least one of said zones; and means for monitoring the total number of people in said zone; for comparing said total number to said limit value; and for causing an action depending on the outcome of that comparison.

The action caused by the system may serve either to restrict or increase the number of people moving into the zone in question or to increase or restrict the number of people moving out of that zone, or both. The latter may be accomplished, for example, by generating an alert for people in that zone to cause them to move to a successive zone.

The action may be taken when the number of people in the zone in question reaches the limit value, or may be taken when the number of people in the zone in question approaches the limit value (e.g. when the number is a predetermined fraction of the limit value, or when the number comes within a predetermined absolute value of the limit value). The limit value may be set to allow for a certain "safety margin" in relation to the absolute capacity of the zone in question.

The limits in question may be determined by commercial criteria, for example, if a particular commercial area is highly populated, but an adjacent commercial area is less highly populated, thus creating an imbalance, there may be advantage in causing movement of people into the less populated area. Thus the limits may be adjusted depending on the relative population of particular zones.

The system of the present aspect may include further optional or preferred features which implement

corresponding optional or preferred features of the method of the previous aspect.

A further aspect of the present invention provides a computer program which, when executed by a computer,  
5 performs the method of the first aspect above. The computer program of this aspect may include further optional or preferred features which perform the corresponding optional or preferred features of the method of the first aspect.

10 Another aspect of the present invention provides a computer program product containing a computer program according to the previous aspect.

#### Brief Description of the Drawings

Embodiments of the present invention will now be described  
15 with reference to the drawings, in which:

Figure 1 is a schematic diagram which illustrates the basic concept of an embodiment of the present invention;

Figure 2 is a schematic diagram of a zone in an embodiment of the present invention;

20 Figure 3 is a schematic diagram of a system according to an embodiment of the present invention.

#### Detailed Description

The embodiments below describe the operation of the present invention in a transport environment. For ease of  
25 reference, the following terms will be used in the description of these embodiments:

"Vehicle" includes but is not limited to a means of transport, such as a plane, lorry, bus, train, car, boat, etc. and may be civil or military in nature;

5 A "passenger" is a person or a group of persons who need to reach a given location (the "departure area") at a given time to embark or disembark from a vehicle - as used below this term also includes the crew of a vehicle, who also need to reach a given location at a given time in order for the vehicle to depart;

10 "Luggage" is an item or a collection of items or cargo, which may be in some way associated with a passenger, and which needs to reach a given location (the "departure area") at a given time in order to be placed on or removed from a vehicle;

15 A "vehicle operator" is the operator of one or more vehicles onto which passenger(s) and/or luggage are to be loaded;

A "facilities operator" is the operator of the whole or a part of the departure or arrival facilities from which the  
20 vehicles are arriving or departing; and

The "departure area" or "destination" is the area from/at which a vehicle is scheduled to leave/arrive at a particular time and therefore where all passengers and/or luggage should arrive for timely departure/arrival.

25 The present invention may be used to increase the probability of on-time arrival of a passenger, luggage, a matched combination of the two, or vehicle crew at the relevant departure area before the scheduled departure time of the vehicle.



The basic concept of an embodiment of the present invention will be illustrated with reference to Figure 1, which shows a number of zones Z1 to Zn. These zones are illustrated in Figure 1 as concentric annuli for convenience, but in reality could take any shape depending on the configuration of buildings or areas of interest. In particular zones may be isolated islands and there may be several pockets of zones within zones.

A passenger (not shown) makes a journey through the zones to the departure area 40, as illustrated by lines 11 and 12; line 11 representing the passenger's journey with their luggage and line 12 representing the passenger's journey after being separated from their luggage at check-in desk 35. From the check-in desk 35, the luggage follows a separate route, illustrated by line 13, to the departure area 40.

For each zone, the local physical distance which has to be covered by a passenger or by luggage to pass from the previous zone to the next zone (D1 to Dn respectively) is either known, or can be calculated by the system embodying the invention as a function of one or more of the travelling behaviour of the passenger or luggage, local prevailing conditions and the required or preferred paths through that zone.

As a consequence, the total distance (T1 to Tn respectively) between the passenger and/or luggage in a particular zone and the departure area 40 is also known, or can be calculated by the system embodying the invention.

The vehicle is scheduled to leave from a departure area 40, which may be a specific point in Z1 as shown in Figure 1,

or in alternative embodiments may be set up as Z1 itself, at a well-defined time. The object is to ensure that the passenger, luggage or matched combination, as appropriate of the two arrive at the vehicle in good time before  
5 departure so that there is a high probability of the vehicle leaving at its scheduled departure time.

Since the distances are known it is possible to calculate or estimate the time by which a passenger or luggage must be in a particular zone ( $Z_n$ ), or have crossed from one zone  
10 ( $Z_n$ ) to the next zone ( $Z_{n-1}$ ) such that the passenger or luggage has sufficient time remaining to complete the journey 11, 12 or 13 to the departure area 40 by the required time. This estimate can also be based on local flow information such as the length of time it has taken  
15 previous passengers and/or luggage to make a similar journey.

This methodology is implemented in a system which processes the information from remote identification devices, such as sensors and tags. The system of the present embodiment  
20 also includes means capable of broadcasting appropriate messages to passengers or facilities operators, for example using speaker systems, display screens or SMS messaging.

This embodiment of the present invention uses a so-called "right to left" time plan which works backwards in time  
25 from an event which is scheduled to take place at a predetermined time (although that time may be altered during the embodiment), which in this embodiment is the departure of the vehicle from the departure area at the scheduled departure time. This is also referred to as a  
30 "pull" system for the entity (e.g. passenger, vehicle crew or luggage) since each stage in the movement of the entity

is driven by the need to meet future requirements rather than by previous events.

The processing of data generated by the sensors and detectors is carried out by a zone management system, which also handles the creation of required incidents for each entity (e.g. passenger, vehicle crew or luggage) and registers correspondences between the data generated by the sensors and detectors and the required incidents. The zone management system may be implemented in a dedicated computer system, or may be implemented on computer systems which are already in use at the facility. Parts of the zone management system may be implemented on interconnected computer systems.

The system is set-up to increase the probability that all passengers, vehicle crew and/or luggage as applicable are "pulled" into a particular zone by a particular time, with the ultimate object of their arrival in the departure area by the predetermined time to allow prompt departure of the vehicle at its scheduled time. Where possible, the system is set up to minimise the impact on the passenger or on the staff of the vehicle or facilities operator.

Preferably the interrogation of sensors or tags is carried out early enough in the journey, as a result of the time references on the required incidents, to allow for corrective actions to take place if an entity has failed to move as required through one or more zones.

At predetermined times before the passenger embarkation is required for smooth departure of the vehicle, one or more sensors are activated in the appropriate zone or in the departure area. This activation of sensors may be

automatic, as a result of required incidents with an imminent time reference, or may be done at regular intervals. If the sensor fails to generate a match for any passenger or luggage in an appropriate zone such that a correspondence is made with a required incident before the time reference of that required incident, an alert is generated which is aimed at resolving the failure, for example by reminding a passenger to proceed to a particular area of the facility (security check, passport control, gate, etc.) or by messaging the luggage handling operations to expedite the arrival of the luggage entity.

The presence of sensors throughout the facility may mean that it is possible to locate the passenger or luggage to which the alert relates, and thereby target the alert, for example by only making an announcement over a particular set of loudspeakers, or on a particular selection of screens.

It is preferable that the identifiers can be encoded and/or programmed and thus the identifiers associated with passengers and/or luggage are encoded with details regarding one or more of: the passenger themselves; the passenger to which luggage belongs; trip details of the passenger; etc.. This information may also be held in the zone management system.

Optionally, the identifiers may be programmed with the maximum lengths of time that passengers or luggage are likely to take to travel through each zone on their route to the departure area, as well as the predetermined time by which the entity must reach their destination. With this information locally held on the identifier, sensors located at particular points along the journey route to the

departure area only need to have accurate time information (e.g. a clock) to check whether the identifier associated with a passenger or with luggage passes the sensor location with enough time left to reach the next zone and/or the departure area in good time.

The identifiers may be encoded either by the arrival of the passenger in the facilities or as the identifiers pass through the zones. Thus programmable identifiers may be updated as they pass through the zones, for example to reflect changes in operational conditions within the facility.

The data on the identifier or in the system may be supplemented by a code associated with the statistical travel behaviour of passengers and/or reliability data on the luggage transportation system. With such information, a local evaluation of the time left to reach the next zone or departure area can be calculated in the sensor and associated systems to improve the chances that the passenger and/or luggage reach the next zone or departure area in good time. If there is a possibility that this will not be the case, the sensor could raise an exception message which is picked up by the zone monitoring system, resulting in appropriate action being taken, such as the generation of an alert.

Alternatively, the identifier could be put into a state corresponding to a particular zone and/or time by sensors placed at particular locations or areas along the journey to the departure area, so that when it is interrogated by sensors in the same area, or broadcasts its state to local sensors, the sensor would be able to determine whether the identifier (and therefore the passenger or luggage) is in

the right area. If this is not the case, the sensor raises an exception message to the zone management system. As an alternative, if the identifier itself has processing capability, it may raise the exception message itself, through the sensor. The exception message may include personal and trip details for the passenger or luggage, to allow the appropriate alert to be generated or simply the identifier (e.g. the barcode number, or in the case of an RFID, a unique hardcoded very large number ("EPC number")) carried on the tag or pass which, when related to the central system is compared with a centrally held entity register prompt the central system to generate an alert.

In a development of the above alternative, where the identifier is increasingly sophisticated, the identifier also contains the personal and trip information. The sensors then only need to broadcast information regarding their location (or zone) along the journey to the departure area, and time information (although this may also be included on the identifier in the form of a clock). If the identifier recognises that it is not in the zone that it ought to be in order for the passenger or luggage with which it is associated to reach the departure area in good time, the identifier can raise an exception message through the sensor which is then handled by the system.

In a development of the above, the sensors could relay simple information to passengers in their range using one of a variety of means, such as a display or voice message, which may include relevant information such as the time that they have left to reach their vehicle in good time and the location of the vehicle/departure area that they have to reach or display or convey (e.g. by a voice announcement, a sign on a screen of the sensor, a print-out

or a message provided to the passenger's mobile phone, PDA or portable computer, for example by Bluetooth, infra red connection or SMS/MMS) the directions from the current location to the vehicle/departure area.

- 5 Other arrangements which result in the generation of data regarding the location of the identifier at a particular time also form part of the present invention.

10 In a development of the system, local readers (i.e. devices capable of interacting with identifiers) may be provided in addition to the system's network of sensors. These local readers may be embodied in fixed, portable or mobile devices ranging from consumer products such as mobile telephones or personal organisers to cheap devices specifically produced for this purpose. The local readers  
15 may be connected to the system through fixed lines or wirelessly.

The local readers could be located at the entrance of cinemas, close to shop tills, on shelves or at any other location, or carried by passengers/crew as described above.

- 20 Such local readers do not form part of the core system infrastructure, but may be provided as part of an extended system infrastructure according to performance and security considerations in the system design.

25 The local readers interface with the core system using a defined protocol and can be updated regularly with data from the core system such as departure times, locations and other such information. Thus they can take into account variations in operational conditions and, for example if the local reader has display capability, adjust the  
30 information displayed on it.

The local readers may be owned by passengers/crews or by businesses located inside the facilities (e.g. the airport terminal) and can provide both businesses and

5 passengers/crews with additional benefits. The local readers may be "independent" sensors in that they contain local processing power to provide their owner or user with information, such as the time left before departure, through the interrogation of data on the passenger/crew's identifier. For example, they may show the scheduled  
10 departure time which may be augmented by a cross-check with the system's updated schedule information. By having local processing power, the local readers do not draw significantly on the processing power of the core system infrastructure.

15 In another embodiment, the local reader could inform the passenger/crew whether or not they have the time to take advantage of a locally offered service such as buying a special offer, going to a business lounge, going to a cinema, using a swimming pool or fitness centre. This  
20 information may be provided or calculated by a local reader carried by the passenger or crew, or by a local reader provided or operated by the service provider.

In a further embodiment, the local reader could provide the system with statistics on passenger movements in their  
25 sensing range. Such statistics could be used, for example, by business managers to tailor their service offerings to take account of the time that passengers/crews have available in their area.

Through the use of all the sensors and local readers to  
30 provide statistics to the system, such local data can be available at a fraction of the cost of having sensors



throughout the whole facility, especially if the local readers are either owned by passengers/crews, for example as part of mobile devices that they own, or are provided by local businesses or areas in the facility because it provides them with better customer/user intelligence and offers corresponding benefits to those businesses.

Such a service would enable the creation of cinemas and other forms of entertainment and businesses providing activities for passengers/crew which are not currently possible due to passenger/crew uncertainty over the amount of time they have available. Passengers and crew would feel more comfortable about paying for a service or using a service (e.g. business lounges in an airport embodiment) which they feel they have the time to take. Such businesses could also operate on price elastic/demand management using statistical or real-time data.

Arrangements such as those described in the preceding paragraphs would be especially useful for so-called "hub and spoke flights" (e.g. long-distance international flights or international flights combined with local connections) during which passengers/crews often have significant time to spend in airport facilities between connections.

In a further embodiment, local readers carried by passengers/crew may provide the passengers/crew with a warning when their tagged luggage arrives on the conveyor belt or when they leave the luggage conveyor belt area where they are supposed to collect their luggage from upon arrival at their destination. Alternatively, local readers may be carried by crew who are located in the luggage

reclaim area in the arrival terminal or may be static units placed in that area.

This embodiment offers the passengers/crew the ability to relax as they do not have to stand around the luggage reclaim belts looking for their luggage. This embodiment may also decrease the chance of luggage being lost in the arrival area through theft, through forgetting that luggage needs to be collected, through confusion with someone else's luggage or for other reasons.

10 The system, either in its basic form, or in conjunction with the local readers described above, may also be used to collect data for statistics such as whether: there is a particular profile of people arriving late at a departure area; it is always the same people who arrive late at the gate; there is a particular profile of people who only move to the next zone when an alert is generated; etc.. These statistics may be used to allow operators to take preventative action, for example by adjusting the time references of required incidents created for such people accordingly, or by targeted marketing.

In addition to the above statistics, the system may also collect data for analysis which can be used to determine trends in passenger movement and type of passengers over the course of a day, week, or year. The results of this analysis for previous days, weeks or years is used when determining the time (and/or place) references of the required incidents which are created for current users of the system to take account of busy periods. Such analyses can provide additional insights into how passengers behave when analysed in conjunction with departure schedules, time of year and other operating conditions inside, outside of

the facility and with the transportation assets and operator of such transportation assets.

In a further development, the sensors and identifiers which are part of the core system are arranged to address the issue that, when passengers/crew approach areas where sensors are used to determine whether the passenger/crew has progressed to a different zone, this determination is not always a trivial exercise. For example, passengers/crews may pass by the sensor but stay in their current zone or go slightly into the next zone and then return to the previous zone. Desirably, the sensors can therefore correctly determine where the identifier associated with the sensed passenger/crew member is.

One arrangement that addresses this issue is to use a multitude of sensors which are arranged in such a way that they provide an unconditional zone determination. An embodiment of this arrangement, which is particularly useful where the passengers/crew have to pass through a "choke point" between zones, includes two or more rows of sensors. One line of sensors is located at the start of the choke point, and a further row is located at the end of the choke point. Passengers who have passed through or are close to the first row are defined as 'possibly in transit between two zones', whilst those who have reached the other row at the end of the choke point are deemed to have reached the new zone.

In an alternative arrangement, sensors can determine passenger locations within their detection range by sending a signal to the identifier and measuring the time that it takes for the signal to travel between the sensor and identifier or for a reply to be received from the

identifier that it has received that signal. The time for the signal to reach the identifier is proportional to the distance between the sensor and the identifier. Use can also be made of the Doppler effect to determine the direction of movement of the identifier.

Rather than using rows of sensors such as the first arrangement described above, simpler arrangements of rows and single sensors with such timing functionality can then fully define the location of the passenger/crew with fewer sensors. Sensors which are directional in their nature, their field of detection providing a line of sight detection over several metres rather than a spherical or disc-like emission volume, can also be used to determine passenger locations.

The use of sensors with timing functionality can thus determine the transfer of passengers/crew from one zone to the next. As the passenger/crew approaches the sensor, the time measured by the sensor associated with the distance between the passenger/crew and sensor will decrease over time and go through a minimum at the point of closest approach before increasing again as the passenger goes away from the sensor. Thus one sensor may be enough to define whether or not the passenger and/or crew has passed into the next zone.

The above approaches may be combined with physical signs and/or structures present at choke points, such as a corridor or line on the floor which ensures that passengers can only travel in a particular direction combined with one way signs which prevent or discourage passengers from going back where they came from.

The above considerations also apply to luggage,  
particularly in situations where it is not on placed on a  
flow system such as conveyor belt, but is transported by  
other systems which do not necessarily behave in simple and  
5 predictable ways, such as trolleys or motorised carts.

The above developments of the sensor(s) and their  
interaction in the system may be combined with the  
developments of the identifier described earlier (such as  
the switching of the information contained on the  
10 identifier from one zone to the next as the passenger  
progresses through zones). This can provide the system  
with an increased level of confidence that the passenger is  
in a particular zone, without the need to have a full  
triangulation of the identifier by sensors placed  
15 throughout the facility. This has the advantages that  
fewer sensors are required and that less data is generated  
in total by all sensors.

A worked example of an embodiment of the present invention  
20 which relates to a (male) passenger preparing to catch an  
international flight is now described in relation to  
Figures 1 to 3.

The term "system" will be used to refer to a system  
operating according to the present invention. The system  
25 is implemented on a dedicated computer system 50, which is  
connected to a data storage means 55 via a network 57.

The tags/sensors used in the airport are RFID based,  
although other systems may be used such as barcodes printed  
on the passenger's boarding card and barcode readers.

1. The passenger 10 receives an automatic SMS message from the system prompting/reminding him that he has to leave in order to catch the plane scheduled to leave from the departure area at the time printed on his flight ticket. The message is issued to his mobile phone. In all instances, an itinerary can be issued to the passenger so that he has an improved chance of reaching the airport in good time. This itinerary may be linked with a GPS system which gives precise directions to the airport or using coarse zones defined by mobile phone tracks which identify the passenger's position within coarse mobile phone zones (so called "cells").

Additional messages could be issued during the passenger's journey to the airport with the assistance of GPS/mobile phone tracking and/or generic tracking devices such as wOzNet™. The passenger could also be linked to, or provided with data from, third party traffic advice systems and receive updates from the system based on the input from these systems.

20 The crew of the aircraft can be handled by the system in a similar way to that described here for the passengers, in that they also have to reach the vehicle at a particular time to ensure its prompt departure. This time may be the same as or different from the corresponding time for passengers and may vary for crew members with different responsibilities.

If the system knows the starting point of the passenger's journey, this message is issued so as to reach the passenger before the maximum anticipated time to departure, which may be based on the time needed to get through all the zones to the departure area according to

available operational data. In this way, if there are delays occurring at the airport terminal, the passenger can be advised to leave earlier than they might otherwise have done.

5           If the system does not know the passenger's starting point, this message is issued as a general reminder in advance of departure that the passenger should be within a particular range of the airport, or within a particular travelling time of the airport.

10       2.    The passenger 10 arrives at the airport with luggage.

          3.    The passenger 10 checks in at a check-in desk 35, which is located in the first zone which has sensors 20 (if the system has allocated one or more zones to the area outside the airport for the purposes of step 1. above, this will not necessarily be the first zone of the system that  
15           the passenger 10 passes through).

          Staff at the check-in desk 35 issue the passenger with an embarkation ticket or boarding card to which an RFID tag is securely attached. Passengers are accustomed to keeping  
20           this item securely with them at all times prior to boarding the aircraft as it is the only means by which he can board the plane. The RFID is encoded with a number or code associated with the passenger's personal and trip details. The system records these details on data storage means 55,  
25           which may happen as a direct consequence of the checking-in procedure, for example by linking the check-in system to the network 57.

          The increasing use of "e-tickets" can mean that the boarding card is issued later in the process. However, the  
30           same principles apply. Likewise, the passenger may chose

to check-in with an automatic check-in machine, in which case the boarding card issued by the machine has an RFID which is encoded by the machine.

Alternatively the RFID issued to the passenger may be  
5 attached to other items or to a tamper proof bracelet such as those issued at large public events. However, association with the boarding cards or embarkation tickets that passengers are used to receiving and looking after may help to reduce any passenger opposition to the system.

10 If the passenger has luggage, a further RFID tag is placed on the luggage (in addition to the usual bar codes etc.), which is also encoded with a number or code associated with the passenger's personal and trip details. The system records these details, including the association  
15 between the luggage and the passenger.

4. The system creates in data storage means 55 a number of required incidents, each having a place reference and a time reference associated with it. The time reference of each required incident is based on the scheduled departure  
20 time of the flight and the distance to the gate area. The exact time reference for each required incident may be set using other data, for example regarding local operating conditions such as delays, or based on the passenger's ticket type.

25 5. The passenger 10 proceeds to passport control 30. The area of passport control is set up as zone Z1 and has a plurality of RFID sensors 20. The sensors 20 may communicate with the computer system 50 wirelessly (25 in Figure 2) or through a network (52 in Figure 3). The  
30 system can therefore check that the passenger 10 has



entered the passport control zone Z1 in good time to allow him to reach the relevant gate/departure area 40 in time. Since this passport control 30 may be a choke point in the journey of passengers, i.e. all passengers travelling to  
5 all departure areas have to travel through this zone, the system may also monitor the progress of passengers through the zone Z1 to determine local operating conditions and whether it is necessary to allow more time for future passengers. According to this information, the system may  
10 change the time references associated with required incidents that have the passport control zone Z1 as associated place references.

The presence of the passenger 10 in the passport control zone Z1, or more particularly of the RFID  
15 associated with them, is detected by the sensors 20, which generate a match which corresponds to a required incident, provided that the passport control zone was the associated place reference for a required incident associated with that passenger.

20 In addition, a plurality of passive infra-red detectors (not shown) are positioned to detect each person who passes through passport control zone Z1. A sensor 20 is arranged in conjunction with each passive infra-red detector to detect the identifier carried by each such  
25 person. The infra-red detectors and the corresponding sensors 20 are connected to a sub-system which checks that for each person detected by the infra-red detector, a corresponding identifier is detected by the sensor 20. If a corresponding identifier is not detected, then the sub-  
30 system raises an alert, for example by notifying staff in the zone, who can check why the person does not have an identifier with them.

The sensors in question may form part of the overall arrangement of sensors in the zone or may be dedicated to this particular purpose.

If the passenger 10 has failed to arrive by the time reference of the required incident associated with them and having the passport control zone as its associated place reference, the system generates an alert. This alert may prompt the facilities operator to make a call for the passenger, or may make this call automatically through an automated voice system 58 and/or using other broadcasting means 59 or personal messaging systems, such as SMS.

6. The procedures associated with step 5 above are repeated for other zones in the airport, particularly at other choke points that the passenger 10 has to pass through to reach the departure area 40.

7. If the passenger has luggage, similar zones are set up to check that the luggage has reached the facilities operator, has been security checked, etc. by a given location and time in the process, in order to ensure timely delivery to the aircraft for loading. If the luggage has failed to reach a particular zone in the process by the time reference associated with a required incident for that zone, then an alert is generated by the system, which may prompt the facilities operator to check on the progress of the luggage, or to increase its priority.

8. The passenger 10 arrives at the departure area 40. An RFID sensor 20a detects the arrival of the passenger 10 in the departure area and generates a match which corresponds with the final incident (assuming that the time reference associated with the final incident has not already passed).

Another RFID sensor (not shown) detects the arrival of the passenger's luggage at the plane (depending on the range/sensitivity/location of these sensors, they may be the same). If the passenger fails to arrive in the departure area before the time reference associated with the final incident, then an alert is generated as in step 5. above.

If the luggage fails to arrive before departure of the plane, then an alert is generated which informs the vehicle operator of this fact, allowing them to keep the passenger informed and updated, and to make alternative carriage arrangements.

In addition, if the passenger is detected leaving the departure area after the time reference of the final incident, an alert can be generated which asks the passenger to return to the gate immediately.

The present invention can equally be used in an arrival situation, again with particular application to transport systems (e.g. the arrivals area of an airport), for example to match passengers and luggage at the luggage reclaim area (which would function as the "destination" for such as system) and alert facility and/or vehicle operator staff or the passenger if there is a problem with any item, or in order to inform the same people of the ultimate location of the luggage. The system could also cause display of the owner details of each item of luggage that is added to the conveyor belt in the arrivals area.

The present invention finds applications in other systems which lend themselves to a discretised approach of time/zone integration towards a destination where it can be

anticipated that failure of an entity to arrive by a specified time will cause consequential process failure. Systems and methods which implement the above invention in these areas can be readily devised according to the principles described above. In particular, whilst the embodiments have referred to civilian examples, military organisations are increasingly moving towards distributed global/rapid deployment operations combined with "just in time" systems for supply of hardware and equipment, which may be handled by outsourced contracts. The matching of passengers (soldiers) and luggage (assigned equipment) as provided for by embodiments of the present invention will have increased importance. The principles of the invention could be used to determine kit preparation and readiness in military or police applications prior to boarding any transport means in order to ensure delivery of the full individual and equipment capability on the field of battle in a timely manner, and reducing or preventing delays resulting from late arrival of either equipment or personnel.

While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.